COLONISATION BY ANTS OF A PLANTED BUSH GARDEN PLOT IN PERTH, WESTERN AUSTRALIA

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ABSTRACT

A survey was undertaken of the ant fauna of a planted bush garden (350 m²) at the City Beach Primary School, Perth, Western Australia. Although the bush garden had been planted with flora native to the area, we found that its ant fauna most closely resembled that of surrounding modified habitats (lawn, and lawn under trees) rather than that of local woodland. Two cosmopolitan tramp ants, present in large numbers in the bush garden, may have been advantaged over many native ant species by local factors such as the relatively small size of the bush garden, and the use of wood shavings to line paths in the garden.

INTRODUCTION

Ants have been widely employed as indicators of environmental quality because of their high diversity, the ease with which they can be sampled and identified, and their responsiveness to changes in the environment (Majer 1983, Anderson 1990). The effects of mining (Majer and Nichols 1998), pollution (Madden and Fox 1997), agricultural activity (Scougall *et al.* 1993), invasion by exotic ant pests (May and Heterick 2000) and urbanisation (Majer and Brown 1986) have all been analyzed using ants as biological indicators.

In 1989, an area of lawn at City Beach Primary School, Perth, Western Australia, was converted to a bush garden plot. Planting took place in four stages, with the first planting being undertaken in May 1990 (in an area of approximately 100m²), with additional ground being added with each subsequent stage. The last planting was in 1994. The aim was to foster environmental awareness among young students enrolled at the school. The garden area measures approximately 350m², and has been planted or seeded with an estimated 34 species of plants, all of which are native to the Quindalup dune system associated with this region. However, at least one orchid species has appeared in the garden, possibly from old rootstock. Lawn surrounds the garden, and part of the lawn near the garden still has an overstorey of scattered Tuart *(Eucalyptus gomphocephala)* and River Red Gum (*Eucalyptus camaldulensis*) trees. Between 25 April 2000 and 2 May 2000, a survey was conducted examining the effectiveness of the bush garden as a haven for native invertebrates. At that time the garden was found to have a layer of scattered wood shavings, originally provided for pathways through the garden. The significance of this is discussed below. For the purpose of analysis, ants were selected as a surrogate for other invertebrate species. This report evaluates how closely the ant fauna of the developing bush garden approximates that of the original native ecosystem the garden is designed to recreate. We proceeded by comparing the ant fauna of the garden with that of (1) the nearby lawn, (2) the lawn with Tuart overstorey, and (3) with that of two areas of similar native bushland that would formerly have existed at City Beach Primary School. These two areas were situated in nearby Bold Park.

METHODS

Five transects, each 20 m long, were measured out. One transect was established in the lawn areas (L), one in the lawn near the tuart trees (LT), one in the bush garden (BG), and two in separate areas (one in closed woodland (W1) and one in a more open aspect (W2)) in bushland in Bold Park. Ten pitfall traps were inserted in the ground an even distance apart along each of these transects. These traps were plastic vials with a 41 mm internal diameter, containing 25 ml of alcohol/glycerol (70/30 v/v). The traps were left open for seven days.

At the end of the trapping period the traps were emptied, and the ants sorted to species level using the Jonathan Majer (JDM) Ant Collection in the Department of Environmental Biology, Curtin University of Technology, as a reference. Analysis of the ants was conducted employing the variables of ant species richness, ant species diversity and ant species evenness. Ant species richness was the total number of species collected from each transect. Ant species diversity is here expressed by the Shannon-Weaver diversity index (H'), determined by the formula

$$H' = n \log n - \Sigma f_i \log f_i / n$$

where n is the total number of specimens in the sample, and f_i is the frequency of specimens of an individual species in the same sample. Ant species evenness, also expressed as an index, was determined by the formula:

$$J' = H' / H'_{max}$$

where H'_{max} is the logarithm of the total number of species in the sample.

Presence-absence data from each site were then used for cluster analyses using the SYN-TAX® computer package (Podani 1995). Sorensen's similarity index was used in both analyses as it has been shown to be one of the most reliable measures for use with binary sets of data (Huhta 1979).

RESULTS

A total of 2280 ants, representing 33 species, was collected in the pitfall traps. Of these species, 9 were found to be undescribed or of uncertain identity. In this report, therefore, each of the latter has been assigned the JDM voucher number designating that particular species in the JDM Ant Collection. The bush transects (W1 and W2) produced the smallest number of individual ants (27 (9 species) and 20 (20 species), respectively), but had the highest species diversity (0.80 and 1.13) and species evenness (0.83 and 0.87) indices. The bush garden transect (BG) produced 696 (14 species), but the species evenness and species diversity indices were only 0.35 and

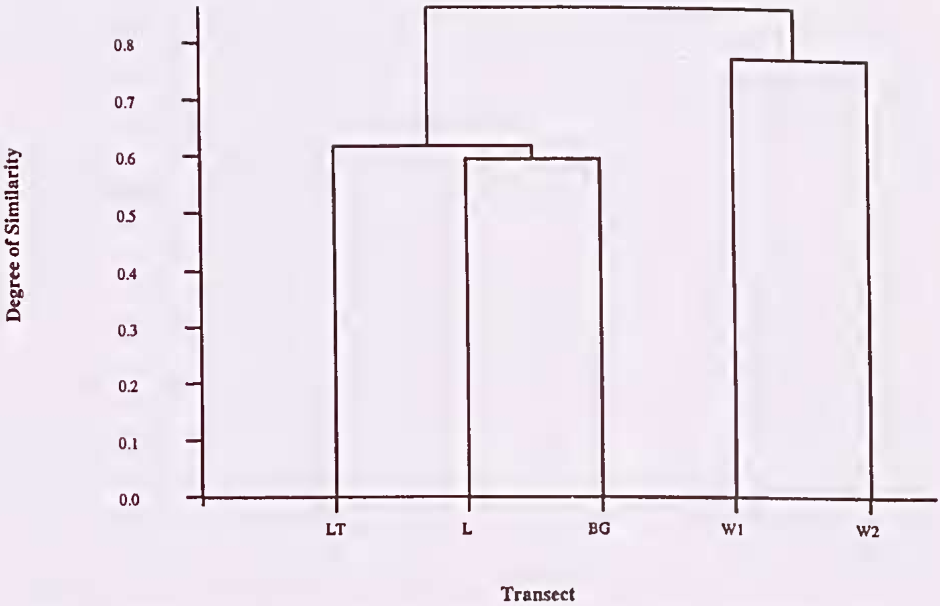

Figure 1. Dendrogram based on ant species presence/absence data illustrating the degree of similarity of the four plots in terms of their ant community composition.

0.31, respectively. The lawn transect (L) and lawn-with-trees transect (LT) showed a similar profile to BG (i.e., 551 individuals (13 species); 0.34 and 0.30; and 936 individuals (13 species), and 0.42 and 0.38, respectively). The above details are shown in Fig. 1.

When the species composition of the catch was analyzed, the reason for the high overall ant numbers from the transects set up in altered environments (i.e., BG, L and LT) was obvious. Just three ant species, *Iridomyrmex chasei* (native to the area), *Tetramorium bicarinatum* (introduced) and *Tetramorium simillimum* (introduced), provided the bulk of the ant individuals in these three transects. In BG, *I. chasei* provided 6.5% (45 ants), *T. bicarinatum* 0.9% (6 ants), and *T. simillimum* 82.8% (576 ants) of the overall catch. For L the figures were 0.4% (2 ants), 82.4% (454 ants) and 6.4% (35 ants), and for LT, 32.8% (307 ants), 0.3% (3 ants) and 60.8% (569 ants). The percentage occupied by these three species out of the total ant fauna sampled was surprisingly similar across the three transects (i.e., 90.2% (BG), 89.2% (L) and 93.9% (LT)). The sum of individuals of the remaining species recorded from the transects comprised 10% or less of the catch. In the two bush transects, however, the individuals of no species comprised more than 20% of the overall catch.

The cluster analysis showed that the ant composition of the woodland transects W1 and W2 was similar, and quite distinct compared with the other three transects. The similarity between transects BG, L and LT was even more marked, with BG and LT being the most similar (Fig. 2).

Table 1. Species and numbers of ants collected in the two bushland and three school plots showing the overall ant abundance, species richness, species diversity and species evenness index in the four areas.

Ant taxon	Bush transect 1											Bush transect 2										
	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total
Anonychomyrma itinerans perthensis (Forel)					1						1						3					3
Camponotus chalceus Crawley											0											0
Camponotus claripes sp. gp. (JDM 25)											0						1					1
Camponotus terebrans (Lowne)											0									13		13
Cardiocondyla nuda (Mayr)*											0											0
Crematogaster laeviceps chasei Forel			1								1											0
Dolichoderus clusor Forel		1									1				1							1
Iridomyrmex bicknelli sp. gp. (JDM 14)											0											0
Iridomyrmex chasei Forel		6	1								7	3					1					4
Iridomyrmex rufoniger suchieri Forel											0											0
Iridomyrmex sp. JDM 12										2	2											0
Melophorus insularis Wheeler											0										1	1
Melophorus sp. ANIC 3											0		1	1						2		4
Melophorus sp. JDM 230			2								2											0
Melophorus sp. JDM 783											0			1						3		4
Meranoplus rugosus Crawley											0		1		2							3
Monomorium arenarium Heterick [in MS]											0					2						2
Monomorium leae Forel											0										1	1
Monomorium sydneyense Forel											0	1	11	2								14
Ochetellus glaber gp. (JDM 19)											0		1	2				1				4
Pachycondyla (Brachyponera) lutea (Mayr)											0										1	1
Paratrechina obscura (Mayr)*											0											0
Pheidole megacephala (Fabricius)*											0											0
Pheidole sp. JDM 874											0											0
Rhytidoponera levior Crawley	1	2	3	1			1		1		9		1	1			1	2		1		6
Rhytidoponera inornata Crawley		1		2							3											0
Rhytidoponera violacea (Forel)									1		1									1	1	2
Solenopsis clarki Crawley											0		3									3
Stigmacros brooksi McAreavey											0			1								1
Stigmacros sp. JDM 115											0						1					1
Strumigenys perplexa (F. Smith)											0											0
Tetramorium bicarinatum (Nylander)*											0	1										1
Tetramorium simillimum (F. Smith)*											0											0
Ant abundance	1	10	7	3	1	0	1	0	2	2	27	5	18	8	3	2	7	3	0	20	4	70
Ant richness											9											20
Ant diversity											0.80											1.13
Ant evenness											0.83											0.87

Table 1 (cont.)

Bush garden transect											Lawn transect											Trees-and-lawn transect										
1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total
										0											0											0
1										1											0											0
										0											0					1						1
0										0											0											
3										3		1	1	3	9	2	3		5	4	28											0
										0											0	3				1		9				13
			1							1	1										1											0
3	1									4		2		1	8		1				12	1			1							2
14	12	1	6	2			3	5	2	45			1						1		2	54	134	6	1	88	3	6	15			307
2	3	1	2		1	1		3		13					3		2	1	2		8	2			12	2	2		1			19
										0											0											0
9			1							10											0		1		4			1				6
5										5											0											0
										0											0											0
										0											0											0
										0											0											0
										0											0											0
										0											0											0
1										1			1								1											0
										0											0											0
2									1	3											0	2										2
3			9							12	3		2								5	3										3
										0	1										1											0
										0			1								1	2										2
										0											0			1		2	3	1	1			8
										0											0											0
8	3	1			1	1	1		1	16					1						1				1							1
										0											0											0
										0											0											0
										0											0											0
										0	2										2											0
1	3	1						1		6	18	13	34	37	55	102	99	10		86	454				1	1		1				3
123	94	22	77	11	10	39	14	41	145	576	6	3	6		3	6	1	2	3	5	35	160	55	35	38	99	20	106	56			569
175	116	26	96	13	12	41	18	50	149	696	31	19	46	41	79	110	106	13	11	95	551	227	190	42	58	194	28	124	73	0	0	936
										14											13											13
										0.35											0.34											0.42
										0.31											0.30											0.38

DISCUSSION

Perhaps the most significant finding from the survey was that the bush garden ant fauna was highly similar to the lawn ant fauna, and that from lawn under trees. However, the ant fauna from all of these sites was substantially different to that of unmodified local environments. This has meant that six years of cultivating a relatively large (350 m^2) plot containing vegetation native to the area has not resulted in an ant fauna similar to that of surrounding native bushland.

The two tramp ant species, *Tetramorium bicarinatum* and *Tetramorium simillimum*, were a major component of the three modified sites, but were almost completely absent (one individual of *T. bicarinatum* in W2) from the two bush transects. *Tetramorium simillimum* is a tiny species most frequently found in twig and leaf litter in gardens (B. E. Heterick, pers. obs.). Consequently, it was no surprise that it was in highest numbers in BG. *Tetramorium bicarinatum*, on the other hand, is a well-defended medium-sized species with a functional sting, and can often be seen foraging in more open terrain such as lawn. The other major species, the native odorous ant *Iridomyrmex chasei*, was present in both bush transects, but in low numbers (seven and four individuals respectively). This species occurred in low numbers in lawn (L = 2 individuals), but was found in larger numbers under trees (LT = 307) and in the bush garden (BG = 45). The presence of nectar, and of honeydew-producing Hemiptera on shrubs and on leaves and twigs of trees seems a reasonable explanation for the higher numbers of *I. chasei* in transects BG and LT. In W1 and W2 its lower numbers could be explained by increased competition for food and nest space with other native ant species, particularly other *Iridomyrmex*.

A second important finding was that no ant species dominated among the catch from W1 and W2, unlike the catch from transects BG, L and LT. This is in keeping with the findings of Majer (1977, 1978) and Majer *et al.* (1982) that ant evenness figures are typically high in lightly disturbed areas (such as Bold Park, in this case) but can be very low in more highly disturbed areas. The latter areas also frequently have very low plant diversity.

Overall, the bush garden has, by and large, failed to provide conditions suitable for the establishment and maintenance of native ant colonies. Admittedly, the rate of ant return to rehabilitated sites is low in Mediterranean climates such as Perth (Majer 1989, p. 165), but in this case the garden was still depauperate in native ant species at least six years after the last planting. Nor is distance from bushland refugia containing native ant species an issue. City Beach Primary School is less than five hundred metres from Bold Park; well within reach of alate, inseminated queens. The presence of scattered wood shavings throughout the garden may deter species that prefer to found colonies in insolated, sandy soil. The wood shavings may contain chemical compounds that are toxic or repugnant to native ant species, but are no barrier to the more adaptable tramp ants. Invertebrate species suitable as ant prey may also be deterred from inhabiting or visiting the garden bed because of the nature of the overlying wood shavings. Perhaps of greater significance is the fact that the dimensions of the garden may not be sufficient to exclude successful establishment of nests by queens from the tramp ant colonies in the surrounding lawn areas. Tramp ant colonies may then successfully kill queens of native ants landing in the garden, or outcompete nascent colonies of native ants.

The Coastal Brown Ant (*Pheidole megacephala*), a major cause of local ant extinctions in the Perth regional area, has now become established in City Beach (B. E. Heterick, pers. obs.). An individual worker of this species was collected from L. Should this ant become established at the City Beach Primary School, which seems likely in the near future, the ant fauna of the bush garden and its surrounds will become even more depauperate.

Additional research to determine whether native invertebrates, other than ants, use the bush garden would be valuable. Species that would otherwise be absent from the area may be benefited by the presence of the garden, even if native ants are not.

In the meantime, efforts should be made by students and ground staff to ensure that garden bed conditions, as well as the nature of the garden plants, should approximate as closely as possible the ground level environment of local native bushland. Subtle, as well as readily visible influences can affect the establishment of a healthy native ant fauna. Attention to these influences will, hopefully, enhance the establishment of native ants and other native invertebrates, as well as the birds and lizards that feed on them. Should Coastal Brown Ants manifest themselves, the use of Amdro® formulated bait will successfully regulate these pests.

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